STANAG 4187
(Edition 3)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: FUZING SYSTEMS - SAFETY DESIGN REQUIREMENTS

Promulgated on 13 November 2001

Jan H ERIKSEN
Rear Admiral, NONA
Director, NSA

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director, NSA under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page (iii) gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page (iv) (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/NSA - Bvd Leopold III, 1110 Brussels - BE.

RATIFICATION AND IMPLEMENTATION DETAILS

STADE DE RATIFICATION ET DE MISE EN APPLICATION

NATION	NATIONAL RATIFICATION REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION / MISE EN APPLICATION					
			INTENDED DATE OF IMPLEMENTATION/ DATE PREVUE POUR MISE EN APPLICATION			DATE IMPLEMENTATION WAS ACHIEVED/ DATE REELLE DE MISE EN APPLICATION		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE								
CA	2441-4187 (DAPM 4-5) of/du 18.10.00	STANAG	12.00	12.00	12.00			
CZ *	6/2-34/2001-1419 of/du 24.01.01	Not implementing / Ne met pas en application						
DA	FKO MAM3 204.69-S4187 9500353-010 of/du 22.02.00	STANAG	12.01	12.01	12.01			
FR								
GE *	BMVg - Fü S IV 1- Az 03-51-60 of/du 12.01.01	STANAG	01.02	01.02	01.02			
GR								
HU								
IT								
LU	BO 6184/99 of/du 07.12.99	Not impleenting / Ne met pas en application						
NL	M200000 1352 of/du 15.03.00	STANAG				09.01	09.01	09.01
NO	NSA-31/01/ FO/HST/ST 4187 of/du 19.02.	STANAG	06.01	06.01	06.01			
PL	17/ROK/P of/du 10.06.00	Not implementing / Ne met pas en application						
PO								
SP	323/05/NI Num 455 of/du 08.02.01	Not implementing / Ne met pas en application						
TU								
UK	12./15/4187 of/du 18.01.00	STANAG						
US	OUSD(A&T) of/du 15.11.00	MIL-STD-1316	11.00	11.00	11.00			

* See reservations overleaf/voir réserves au verso

+ See comments overleaf/Voir commentaires au verso

RESERVATIONS/RESERVES

GERMANY

In Paragraphs 14b.(1) and 14b.(2) the maximum probabilities of premature arming are given. For Germany it is laid down, that concerning safety and hazard analyse, a fuze (SAD) is considered armed if :
- for fuzes with an interrupted Explosive Trains all safety features are removed, independent of the state of the interrupter of the whole SAD.
- for fuzes with a Non Interrupted Explosive Trains according to paragraph 9b.(2) all energy breaks or switches allow transmission of energy and dynamic switches are working. Independent of the state of the SAD as a whole (e.g. the charge of the Firing Capacitor).

ALLEMAGNE

Les probabilités maximales d'un armement prématuré sont exposées dans les paragraphes 14b.(1) *et* 14b.(2). *Pour l'Allemagne, il est établi que dans le cadre de l'analyse des risques pour la sécurité, une fusée est considérée comme armée si :*
- dans le cas de fusées avec chaînes pyrotechniques interrompues, tous les dispositifs de sécurité sont ôtés, quelque soit l'état de l'interruption du dispositif complet de sécurité et d'armement ;
- dans le cas de fusées avec chaînes pyrotechniques non interrompues, selon le paragraphe 9b.(2), tous les interrupteurs ou commutateurs d'énergie permettent la transmission d'énergie et que les commutateurs dynamiques fonctionnent, quelque soit l'état du dispositif complet de sécurité et d'armement (par exemple, la charge de la capacité de mise à feu).

CZECH REPUBLIC

It will not be implemented yet, there are not available financial means

REPUBLIQUE TCHEQUE

La mise en application ne peut encore se faire pour des raisons financières.

STANAG 4187
(Edition 3)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT
(STANAG)

FUZING SYSTEMS - SAFETY DESIGN REQUIREMENTS

Annexes:

A. National Safety Approving Authorities
B. Definitions.
C. Safety Design Requirements for Naval and Land Service Mine Fuzing Systems.
D. Pyrotechnic Initiated Explosive Projectiles.

Related documents:

AAP-6	NATO Glossary of Terms and Definitions
AECP-1	Mechanical Environmental Conditions to which Materiel Intended for Use by NATO Forces could be Exposed.
AECTP-100	Environmental Testing - Guidelines on Management Planning.
AECTP-200	Environmental Testing - Definitions of Environments.
AECTP-300	Climatic Environmental Tests.
AECTP-400	Mechanical Environmental Test.
AECTP-500	Electrical Environmental Tests.
AOP-7	Manual of Tests for the Qualification of Explosive Materials for Military Use.
AOP-8	NATO Fuze Characteristics Catalogue.
AOP-16	Fuzing Systems - Design Guides.
AOP-22	Design Criteria and Test Methods for Inductive Setting of Electronic Projectile Fuzes.
AQAP-110	NATO Quality Assurance Requirements for Design, Development and Production.
STANAG 1307	Maximum NATO Naval Operational Electromagnetic Environment Produced by Radio and Radar.
STANAG 2895	Extreme Climatic Conditions and Derived Conditions for Use in Defining Design Test Criteria for NATO Forces Materiel.
STANAG 4145	Nuclear Survivability Criteria for Armed Forces Materiel and Installations – AEP-4.
STANAG 4147	Chemical Compatibility of Ammunition Components Explosives and Propellants (Non Nuclear Applications).
STANAG 4157	Development of Safety Test Methods and Procedures for Fuzes for Unguided Tube Launched Projectiles – AOP-20.
STANAG 4170	Principles and Methodology for the Qualification of Explosive Materials for Military Use.
STANAG 4234	Electromagnetic Radiation (Radio Frequency) 200 kHz to 40 GHz Environment Affecting the Design of Materiel for Use by NATO Forces.
STANAG 4235	Electrostatic Environmental Conditions Affecting the Design of Materiel for Use by NATO Forces.
STANAG 4236	Lightning Environmental Conditions Affecting the Design of Materiel for use by NATO Forces.
STANAG 4239	Electrostatic Discharge, Munitions Test Procedures – AOP-24.

STANAG 4297	Guidance on the Assessment of the Safety and Suitability for Service of Munitions for NATO Armed Forces - AOP-15.
STANAG 4324	Electromagnetic Radiation, (Radio Frequency) Test Information to Determine the Safety and Suitability for Service of Electro- Explosive Devices and Associated Electronic Systems in Munitions and Weapon Systems.
STANAG 4327	Lightning, Munition Assessment and Test Procedures – AOP-25.
STANAG 4363	Fuzing Systems - Development Testing for the Assessment of Lead and Booster Explosive Components – AOP-21.
STANAG 4416	Nuclear Electromagnetic Pulse, Testing of Munitions containing Electro-Explosives Devices.
STANAG 4423	Cannon Ammunition (12.7 to 40 mm), Safety and Suitability for Service Evaluation.
STANAG 4497	Hand Emplaced Munitions (HEM), Principles for Safe Design.
STANAG 4518	Safe Disposal of Munitions, Design Principles and Requirements, and Safety Assessment.

AIM

1. The aim of this agreement is to standardize safety design requirements for fuzing systems for operational and training munitions for use by NATO Forces.

AGREEMENT

2. Participating nations agree to design munition fuzing systems in accordance with the requirements of this STANAG. The agreement is applicable to new development of fuzing systems, initiated after promulgation of this STANAG, for all munitions except those listed in Paragraph 3. This agreement shall be applied by the National Safety Approving Authorities (NSAA) listed in Annex A.

EXCLUSIONS

3. The following munitions are excluded from this agreement.

a. Nuclear weapon systems and their associated training aids.

b. Flares and Signals dispersed only by hand.

c. Pyrotechnic Countermeasure Devices.

d. Those munitions which are recognised by the NSAA as being designed to detonate, deflagrate or disperse without constraints on safety at intended functioning.

e. Munitions which the NSAA agrees do not present sufficient hazard as to require a fuzing safety system.

f. Hand Emplaced Munitions.

DEFINITIONS

4. Definitions of terms which are specific to this STANAG are given at Annex B.

GENERAL

5. DESCRIPTION

A fuzing system:

a. Ensures the safety of the initiation system of the munition payload throughout the logistic phases and operational usage as well as testing and inspection.

b. Recognises or determines the circumstances under which the munition payload is intended to function including self destruction and/or sterilization.

c. Enables and initiates the munition's payload.

6. GENERAL CONSIDERATIONS

a. Specific Classes: Safety design requirements for fuzing systems for specific classes of munitions, the environments of which necessitate additional or different design constraints, are stated in the following Annexes:

Annex C: Safety Design Requirements for Naval and Land Service Mine Fuzing Systems.
Annex D: Pyrotechnic Initiated Explosive Projectiles.

b. Design Approval: During the concept development phase, the developing agency shall obtain approval from the NSAA for both the design concept and the methodology for assuring compliance with safety requirements. At the completion of engineering development, the developing authority shall present a safety assessment to the NSAA for review to obtain approval of the design. (See Paragraph 14 (f)).

c. Safety Design Requirements

(1) A life cycle environmental profile shall be defined for the fuzing system which will establish the environmental conditions and limits the fuzing system will encounter throughout its life cycle.

(2) The fuzing system shall be designed to maintain the required degree of safety in credible accident situations and under all specified natural and induced environmental conditions in its life cycle. (See STANAGs 1307, 2895, 4157, 4234, 4235, 4236, 4297 and AECP-1).

d. Application. The features, requirements, procedures and controls listed in this Agreement shall be used in the design of fuzing systems.

e. Guidance. Guidance on the interpretation of the requirements stated in this STANAG is given in AOP-16.

DETAILS OF THE AGREEMENT

7. FUNDAMENTAL SAFETY DESIGN REQUIREMENTS

The following safety design requirements shall apply to all fuzing systems.

a. Inclusion of Safety Features.

(1) Fuzing systems shall include at least two safety features, the operation of which are, wherever possible, functionally isolated from other processes within the munition system and each of which shall prevent unintentional arming of the fuzing system. At least two of the features shall be independent.

(2) At least one of the independent safety features shall prevent arming and functioning after launch or deployment until the specified safe separation distance or equivalent delay has been achieved, having taken account, where applicable, of the normal post-launch or post-deployment characteristics of the munition and the movement of the launcher or deployer.

b. Operation of Safety Features Using Environmental Stimuli. In the fuzing systems of munitions for which at least two environmental stimuli are available, the following shall apply:

(1) The stimuli which enable the independent safety features to operate shall be derived from different environments or different combinations of environments or both; where combinations are used each combination shall be different.

(2) The environments selected in a fuzing system to remove safety features during arming shall avoid any environment or levels of environmental stimulus that may be experienced by the fuze prior to the commencement of the launch cycle.

(3) Operation of at least one of the independent safety features shall depend on sensing an environment after first motion in the launch cycle or on sensing a post launch or unique employment environment.

(4) Any action taken to launch a munition may be considered an environmental stimulus if it irreversibly commits the munition to complete the launch cycle.

(5) Munitions that are designed to be jettisoned shall not have safety compromised by the action of such release.

c. Prevention of Unintentional Arming

(1) Safety design shall ensure that:

(a) Fuzing systems are not capable of being armed manually.

(b) Fuzing systems do not rely solely upon defined operating drills or procedures to provide safety.

(2) Fuzing systems shall be designed so that no single credible circumstance can result in arming before launch or deployment.

(3) Fuzing systems shall not to be capable of arming except as a consequence of a sequence of actions defined by the order of the sensed environments developed during launch or deployment.

(4) Fuzing systems shall use environmentally derived energy generated upon launch or deployment in preference to prelaunch stored energy, in order to enable or arm the system. If environmentally derived energy cannot be practically obtained and stored energy is used, then the system safety hazard analyses shall demonstrate that no failure mode for that source of energy will compromise the specified failure probabilities for that system (See Paragraph 14b.).

(5) Safety and arming devices shall employ safety logic which is dedicated to effect arming alone.

d. Application of Requirements to Multiple Safety and Arming Devices. The requirements at paras 7a. to 7c. apply to all munitions having a single safety and arming device. For munitions with multiple safety and arming devices compliance shall be as follows:

(1) *Independent Safety and Arming Devices*. When a fuzing system incorporates multiple safety and arming devices for which the functions of arming and initiation are independent, the requirements at Paragraphs 7a. to 7c. shall apply to each safety and arming device.

(2) *Interrelated Safety and Arming Devices*. When a fuzing system incorporates multiple safety and arming devices which share common functions of arming, initiation or both, the requirements at Paragraphs 7a. to 7c. shall apply overall to the interrelated safety and arming devices.

e. Fuze Setting. If fuze setting is safety critical (eg arming time, function time, or proximity broadcast turn on time) uncontrolled alteration of the set value shall be prevented.

f. Fail Safe Design. Fuzing systems shall incorporate fail-safe design features based on their applicability to system requirements.

g. Self Destruction. Fuzing systems shall incorporate a self-destruct feature which initiates munition destruction, based on applicability to system requirements. Self-destruction shall not be initiated prior to launch and attainment of the proper arming delay.

h. Disposal. Fuzing systems shall meet the requirements of STANAG 4518.

i. Single Device. The elements of the fuzing system that prevent arming until valid launch environments have been sensed and the arming delay has been achieved should be located in a single safety and arming device.

8. EXPLOSIVES IN FUZING SYSTEMS

Explosive compositions and materials shall be selected as follows:

a. Assessment and Qualification of Explosives. Explosives and explosive compositions shall be assessed and Qualified in accordance with the requirements of STANAG 4170 in their design role (primary, lead, booster, expulsion charges etc).

b. Safety in Storage and Use. Explosive compositions shall be chosen, so that the system is safe and remains so under the specified conditions of storage and use.

c. Sensitiveness. The sensitiveness of the explosives shall not increase significantly during the entire service life of the fuze beyond the level at which they were approved for service use.

d. Qualification and Sensitiveness of Expulsion Charges and Lead and Booster Explosives. Only those explosives Qualified in accordance with the requirements of STANAG 4170 as acceptable expulsion charges and lead or booster explosives are permitted to be in a position leading to the initiation of a high explosive main charge without interruption. The explosive material used in fuzing systems shall not be altered by any means likely to increase its sensitiveness beyond that at which the material was Qualified.

e. Assessment of Explosive Components. Lead and booster explosive components in fuzing systems shall be assessed in accordance with the requirements of and pass the tests specified in STANAG 4363.

9. CONTROL OF EXPLOSIVE TRAINS IN FUZING SYSTEMS

a. Use of Interrupted Explosive Trains. When the explosive train contains primary explosives or explosives other than those allowed by Paragraph 8d., the train is to be interrupted and the following requirements shall apply:

(1) At least one interrupter (barrier, shutter, slider, rotor) shall isolate the primary explosive and/or explosives that do not meet the requirements of Paragraph 8d., from subsequent elements of the explosive train. The interrupter(s) shall be directly locked mechanically in the safe position by at least two independent safety features of the fuzing system until the start of the arming sequence.

(2) The interrupter shall be designed to prevent an explosive event propagating to an acceptor explosive element beyond the interrupter should any explosive housed within or preceding it in the train be initiated prior to the specified safe separation distance or equivalent delay being achieved. The effectiveness of explosive train interruption shall be determined by the Explosive Train Interrupter Safety Tests and Progressive Arm Tests (if armed progressively) given in STANAG 4157.

(3) Designs in which the primary explosive is positioned such that safety is completely dependent upon the presence of an interrupter shall include positive means to prevent the fuzing system from being assembled if the interrupter is excluded or if the interrupter is in the unsafe position.

b. Use of Non-Interrupted Explosive Trains. Explosive train interruption is not required when only those explosive materials allowed by Paragraph 8d. are used in the train. In these circumstances one of the following methods of controlling arming shall be used:

(1) For fuze systems using techniques for accumulating all functioning energy from the post-launch environment, the system shall prevent arming until verification, by the system of a proper launch, and attainment of the required arming delay. Accumulation of any functioning energy shall not occur until as late in the arming cycle as operational requirements permit.

(2) For fuze systems using techniques that do not accumulate all functioning energy from the post-launch environment, at least two independent energy breaks, each controlled by an independent safety feature, shall prevent arming until proper launch is verified by the fuzing system and the required arming delay is attained. Additionally, the fuzing system shall not be capable of arming if any or all of the energy breaks are left out or malfunction (static failure). Where static switches are considered for use as energy breaks, the Design Authority must seek the advice of the NSAA.

(3) *Electrical Initiation*. Electrical initiators used in non-interrupted explosive trains:

(a) Shall be qualified to specific test procedures and pass/fail criteria established or approved by the NSAA.

(b) Shall not be capable of being detonated by any electrical potential of less than 500 V applied directly to the initiator.

(c) Shall not be capable of being initiated by an electrical potential of less than 500 V when applied to any accessible part of the fuzing system during and after installation into the munition or any munition subsystem.

10. ADDITIONAL SAFETY DESIGN REQUIREMENTS FOR FUZING SYSTEMS CONTAINING ELECTROMECHANICS AND ELECTRONICS

The following safety design requirements shall apply to electromechanical and electronic fuzing systems in addition to those given elsewhere in this STANAG.

a. Safety Margins. In any safety and arming system in which safety is dependent on preventing the unintentional functioning of an EED, a minimum safety margin between the no-fire threshold (NFT) stimulus and the stimulus which could be induced by electrical or electromagnetic interference shall be proposed to and accepted by the NSAA.

b. Arming and Initiation. Designs shall ensure that:

(1) Independent safety feature controls (e.g. logic) are physically separated and implemented using different component types to minimize the potential for common cause failures.

(2) The fuze remains safe during tests if either the tested feature or the test function fails.

c. Electrical Firing Energy Dissipation. For electrically initiated fuzing systems, the design shall include a provision to deplete the firing energy after the operating lifetime of the fuzing system has expired. The time required to dissipate the firing energy shall be reduced to the minimum allowed by the operating requirements for the fuzing system. The means of dissipation shall be designed so that it does not degrade the overall safety of the Safety and Arming device before the system is armed.

d. Safety Critical Computing Systems. The safety design requirements for logic features are as follows:

(1) *Information Transfer*. Information passed between an environmental sensor and an arming system shall be transferred by a defined logic route dedicated to that transfer only.

(2) *Interpretation of Information*. Information received by the arming system shall be capable of being verified as a valid command to begin a sequence of events resulting in the removal of a safety feature. False or corrupted data shall not cause the removal of a safety feature.

(3) *Computing Systems*. Non-embedded software shall not be used. If a computing system with embedded software is used to perform the logic function, then it shall be designed to facilitate a safety assessment to the satisfaction of the NSAA (see also para 14e.).

e. Hardware Excluding Computing Systems. If the logic function is performed by totally dedicated hardware to give unequivocal interpretation, the hardware systems shall use components in which all the logic states can be identified, verified and validated. The design selected shall be approved by the NSAA.

f. Electromagnetic, Lightning and Electrostatic Immunity:

(1) *Electromagnetic Immunity*. The fuzing system shall not exhibit unsafe operation during and after exposure to electromagnetic energy including lightning. Immunity from arming or firing due to electromagnetic forms of energy shall be demonstrated by analyses and appropriate tests as necessary which duplicate or simulate credible life-cycle electromagnetic environments. (See STANAGs 4234/4324 (EMR), 4236/4327 (Lightning Effects), 4145/4416 (EMP) and AECTP 500 series (EMC)). Electro-magnetic interference should be tested in accordance with tests approved by the NSAA.

(2) *Electrostatic Immunity*. The fuzing system shall not exhibit unsafe operation during or after exposure to an electrostatic environment. Immunity from arming or firing due to electrostatic forms of energy shall be demonstrated by analyses and appropriate tests as necessary which duplicate or simulate credible life-cycle electrostatic environments. (See STANAG 4235/4239) .

11. COMPATIBILITY OF COMPONENTS

All components used in the fuzing system shall be chosen to be compatible and stable so that under all specified natural and induced environmental conditions in its life cycle, none of the following can occur in an unarmed fuzing system:

a. Premature arming or functioning.

b. Dangerous ejection or exudation of material.

c. Deflagration or detonation of the lead or booster.

d. The formation of dangerous or incompatible compounds. Material which could contribute to the formation of more volatile or more sensitive compounds should not be used. If used, then the material shall be treated, located or contained to prevent the formation of a hazardous compound (see STANAG 4147).

e. Production of unacceptable levels of toxic or other hazardous materials.

f. A compromise of the safety or sterilization features.

12. SAFETY DESIGN REQUIREMENTS TO PROVIDE NON-ARMED ASSURANCE DURING ASSEMBLY AND INSTALLATION

a. To provide non-armed assurance, fuzing system designs shall incorporate one or more of the following:

(1) A feature which prevents the assembly of the fuzing system in an armed condition.

(2) Positive, direct and unambiguous means of determining that the fuzing system is not armed during and after assembly and when installing the system into a munition. For fuzing systems with non-interrupted explosive trains, the method used shall positively prevent the accumulation of energy, of the type used for arming, in the system prior to installation in the munition. Where the fuzing system is accessible after assembly into the munition, the positive means of determination shall also be available. Any means employed in compliance of this paragraph shall not degrade safety.

(3) A feature which prevents installation of an armed fuzing system into a munition.

b. If arming and disarming of the assembled fuzing system in tests is a normal procedure in manufacturing, inspection, or at any time prior to its installation into a munition, the adoption of Paragraph 12a.(1) alone is not sufficient and either Paragraph 12a.(2) or Paragraph 12a.(3) shall also be met.

c. If it is necessary to check individual safety features during or after assembly, the method used shall be unambiguous and positive and shall not degrade safety.

13. EXPLOSIVE ORDNANCE DISPOSAL (EOD)

Features should be incorporated in fuzing systems in accordance with national policies that facilitate their being rendered safe by EOD tools, equipment and procedures even if sterilization or self-destruction features are incorporated.

14. DESIGN SAFETY ASSESSMENT

a. Preliminary Safety Hazard Analysis. An analysis shall be conducted to identify the hazards of normal and credible abnormal environments, conditions and actions of personnel, which may occur before the point of intended functioning is reached. This analysis shall be initiated at the start of a programme or in its early phases (STANAG 4297 - AOP-15).

b. Hazard Analyses. Analyses (Failure Modes and Effects Analysis, Fault Tree Analysis etc) shall be conducted and documented as soon as detailed design information is available. These analyses should evaluate the safety of the fuzing system design in order to estimate the probabilities of a single system failing over its anticipated life cycle, including those due to manual operations. These probabilities shall not exceed the following rates:

(1) *Prior to Commencement of the Arming Sequence*. The probability of arming between manufacture and the intended commencement of the arming sequence shall not exceed one in a million.

(2) *Between Commencement of the Arming Sequence and Safe Separation or Equivalent Delay*. The probability of arming between the intended commencement of the arming sequence and safe separation or equivalent delay shall not exceed one in a thousand. The rate of fuze functioning during this period shall be as low as is practical and consistent with the risk established as acceptable for premature munition function.

(3) *After Safe Separation or Equivalent Delay*. The probability of unintended functioning after safe separation or equivalent delay shall not exceed that specified in the requirement document for the system.

(4) *After Intended Function*. The design of the fuzing system shall ensure that the incidence of hazardous duds shall be at a level acceptable to the User and the NSAA.

c. Hazard Analysis Revision. Hazard analyses shall be updated during development to assess the effects on safety of changes in the design.

d. Critical Components and Characteristics. Components of the fuzing system with characteristics which may be critical to safety shall be identified and appraised in a document which forms part of the fuzing system specification. The evaluation of the critical components shall be presented as part of the design safety assessment of the fuzing system. The applicable drawings shall be annotated to show that the component is safety critical together with the critical characteristics.

e. Embedded Software. For fuzing systems containing an embedded microprocessor, controller or other computing device, the analyses shall include a determination of the contribution of the software to the enabling of a safety feature. Where the software is shown to control directly or remove one or more of the safety features, a detailed analysis and testing of the applicable software shall be performed to assure that no design weaknesses, credible software failures, or credible hardware failures propagating through the software can result in a compromise of the safety features.

f. Safety Evaluation Documentation. The evaluation programme used as the basis of the safety assessment prepared by the developing agency shall be documented in both detail and summary form. The Hazard Analysis relating to fuze failure probability, any revision and any analysis of Safety Critical Computing Systems shall be presented to the NSAA for its assessment.

15. DESIGN REVIEW

Designs shall be certified by the NSAA for compliance with this STANAG. New designs, modifications to approved designs which affect safety, and new applications of previously approved designs shall be presented with supporting evidence to the NSAA for safety evaluation and certification of compliance.

16. WAIVED REQUIREMENTS

If a design does not comply with one or more requirements of this STANAG but is certified as safe by the NSAA, the details of the waived requirements and the rationale on which the waivers are based shall be recorded in the certificate of compliance. The reasons for the waivers shall be made known to other NATO nations justifiably requiring information on the design concerned.

17. DESIGN FOR QUALITY CONTROL AND INSPECTION

Fuzing systems shall be designed and documented to facilitate the application of effective quality control and inspection and test procedures in accordance with AQAP-110. The design of the fuzing system shall incorporate features which will facilitate the use of inspection procedures and test equipment to ensure that no critical design characteristics have been compromised.

IMPLEMENTATION OF THE AGREEMENT

18. The STANAG is considered implemented when participating nations have issued instructions that all fuzing systems for all munition systems, except those listed in Paragraph 5, are to be designed in accordance with this agreement.

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Air Force

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Non-Nuclear Munitions Safety Board
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DEFINITIONS

1. For the interpretation of STANAG 4187 and AOP-16 the following specific definitions apply in addition to those in AAP-6:

a. Armed. A fuzing system is considered armed when any firing stimulus could produce fuze function.

(1) A fuzing system employing explosive train interruption is considered armed when the interrupter(s) position is such that the probability of propagation of the explosive train is 0.005 at the 95% single sided lower level of confidence.

(2) A fuzing system employing a non-interrupted explosive train is considered armed when the stimulus available for delivery to the initiator equals or exceeds the initiator's no fire threshold energy.

b. Arming Delay. A delay between initiation of commit-to-arm, launch or deployment and arming of the fuzing system.

c. Commit-to-Arm. Actions carried out upon a munition, following which the fusing system, irreversibly, will arm.

d. Common Cause Failure. The failure of two or more components due to a single cause. For example two or more components may fail due to the single cause of heating. The mode of failure may or may not be the same.

e. Common Mode Failure. The failure of two or more components in the same mode. For example two or or more components such as switches may fail in a single mode such as open circuit. The cause of failure may or may not be the same.

f. Deactivation. The rendering of a fuzing system incapable of reacting to a firing signal by the issue of a specific command or after a preset delay.

g. Disarm. To restore a fuzing system to a non-armed condition from an armed condition either reversibly, to permit rearming or irreversibly and permanently (Sterilization).

h. Embedded Software. Software fixed in the computer in 'Read Only' memory.

i. Enable. To remove or deactivate safety features which prevent arming.

j. Environmental Sensor. A component or series of components designed to detect and respond to a specific environment.

k. Fail-Safe. A design feature of a fuzing system which renders the munition incapable of arming and functioning upon malfunction of safety feature(s) or exposure to out of sequence arming stimuli or operation of components.

l. Firing Stimulus. A stimulus which will initiate the first explosive element in the explosive train of a fuzing system.

m. Fuzing System. A system designed to:

(1) Provide as a primary role safety and arming functions in order to preclude munition arming before the desired position or time.

(2) Sense a target or respond to one or more prescribed conditions, such as elapsed time, pressure, or command.

(3) Initiate a train of fire or detonation in a munition.

n. Hand Emplaced Munition (HEM). A munition that is manually emplaced at, or is hand thrown to, a point of intended function and that requires user action both to begin its operation and to achieve safe separation. Examples include some demolition charges, grenades and pyrotechnics.

o. Incendiary Mixes. Incendiary mixes are pyrotechnic compositions which upon ignition rapidly convert to high temperature gases and hot particles.

p. Independent Safety Feature. A safety feature which is not affected by the function or malfunction of any other safety feature.

q. Interrupted Explosive Train. An explosive train in which the explosive path between the primary explosive and the lead and booster explosives is functionally separated until arming.

r. Interrupter. A barrier which prevents the transmission of an explosive or burning effect between elements in an explosive train.

s. Launch. The intentional and irreversible discharging, firing, ejecting or releasing of a munition.

t. Launch Cycle. The period from the instant a munition is irreversibly committed to launch until it has left its launcher.

u. Logic Route. The mapping of all functional paths that can be taken through a system operation.

v. No-Fire Threshold Stimulus. The energy stimulus at which the probability of functioning the initiator is 0.005 at the 95% single sided lower level of confidence.

w. Non-Interrupted Explosive Train. An explosive train which has no physical interruption of the explosive elements.

x. Primary Explosives. Sensitive materials used to initiate a detonation or burning reaction.

y. Reactivation Capability. A capability which will cause a fuzing system, having deactivated, to return to a state in which it is again capable of reacting to a firing signal.

z. Safe Jettison. Deliberate release or ejection of a non-armed munition in a manner which ensures that arming cannot occur.

aa. Safe Separation Distance. A minimum distance between the delivery system or launcher and the munition beyond which the hazards to personnel and the delivery system resulting from functioning of the munition system are acceptable.

bb. Safety and Arming Device. A device that prevents the fuzing system from arming until an acceptable set of conditions has been achieved and subsequently effects arming and allows functioning of the payload.

cc Safety Critical Computing System. A computing system containing at least one Safety Critical Function.

dd. Safety Feature. An element or combination of elements of a fuzing system which prevent unintended arming and functioning.

ee. Sensitiveness. A measure of the ease with which an explosive may be ignited or initiated by a prescribed stimulus (an inverse measure of the safety of an explosive against accidental initiation).

ff. Shall. Indicates a provision that is mandatory.

gg. Should. Indicates a provision that, although not mandatory, is highly desirable, and, if it cannot be met, then the reasons should be stated.

hh. Software. The non-hardware elements of a system which include computer programming operating systems, programming languages, data bases and associated documentation.

ii. Sterilization. A planned, programmed process that renders a munition permanently incapable of being fired.

jj. Stored Energy. The capability of a component to deliver energy in addition to any external energy required to initiate its function. Examples of stored energy are springs under load, batteries, charged capacitors, compressed gas devices and explosive actuators.

SAFETY DESIGN REQUIREMENTS FOR NAVAL AND LAND SERVICE MINE FUZING SYSTEMS

1. Fuzing systems for Naval and Land Service Mines, however laid, shall comply with the safety design requirements of this STANAG with additions described in the following paragraphs.

2. Disarming. When required by the Staff Requirement, mine fuzing systems shall include a method whereby the operator can disarm and recover a mine.

3. Anti-Lift and Anti-Recovery. The designs of fuzing systems for these capabilities shall conform to the Requirements of this Agreement.

4. Additional Features. If the Staff Requirement specifies that the mine is to be capable of being neutralized, the design of the fuzing system of the mine shall comply with the following requirements:

   a. Neutralization. The failure of any component of the fuzing system which is not directly involved with neutralization, including sterilization, shall not compromise this capability.

   b. Reactivation.

      (1) It shall not be possible to reactivate a mine unless it has previously been both armed and deactivated.

      (2) Arming during reactivation shall comply with Paragraph 7c. of this STANAG.

      (3) No failure of any part of the fuzing system related solely to reactivation may inhibit deactivation or self-destruction.

      (4) If an external command is used to initiate reactivation, the fuzing system shall validate the command before reactivating and shall not react to an invalid or corrupt command.

   c. Sterilization. The ability to sterilize shall not be compromised by failure of any part of the fuzing system not directly concerned with sterilization.

PYROTECHNIC INITIATED EXPLOSIVE PROJECTILES

GENERAL

1. Pyrotechnic Initiated Explosive (PIE) projectiles utilise non-interrupted explosive trains and yet have no safety and arming systems in the accepted sense. It is therefore necessary to ensure that the explosives and other compositions used in the projectile are safe and suitable for service use in the storage, gun operation and in flight phases.

2. This Annex establishes the design safety requirements for PIE projectiles independently from the body of the STANAG.

3. The requirements of this Annex apply only to PIE projectiles of calibres of 40 mm and below.

DEFINITIONS

4. The definitions given in Annex B of this STANAG apply to the terms used herein.

DESCRIPTION

5. A PIE projectile is one in which:

a. The explosive train is non-interrupted.

b. There is no safety and arming device in the accepted sense and safety is achieved by the use of:

(1) Relatively insensitive incendiary mixes.

(2) Specific impulse levels to achieve initiation.

(3) A combination of projectile configuration and incendiary insensitivity.

c. The explosive charge is ignited by the effects of combustion of incendiary mixes which in turn are ignited by impact on the target and by control of shock energy transfer through physical configuration.

SAFETY DESIGN REQUIREMENTS

6. Incendiary Mixes. The incendiary mixes:

a. Shall be assessed and qualified in accordance with the principles and methodology described in STANAG 4170. Pass/fail criteria shall be established by the NSAA.

b. Shall not contain material which could contribute to the subsequent formation of more volatile or more sensitive compounds.

c. Shall not be altered by any means likely to increase their sensitiveness beyond that for which the materials were qualified.

7. The Explosive Charge. The explosive charge shall be assessed and Qualified in accordance with the principles and methodology described in STANAG 4170. Only those explosives which qualify as leads, booster or main charge explosives may be used as the explosive charge.

8. Materials. All of the materials within the projectile shall be chosen:

a. So that the system is safe and remains so under all specified conditions of storage and use.

b. To be compatible and stable so that under all specified natural and induced environmental conditions in its life cycle, none of the following can occur:

(1) Premature functioning.

(2) Dangerous ejection or exudation of material.

9. Round. The round:

a. Shall be assessed in accordance with STANAG 4423.

b. Shall be so designed that no credible circumstance can result in ignition of the explosive train before being fired.

c. The round shall be tested in accordance with STANAG 4157 and subjected to the following additional tests. Specific test procedures and pass/fail criteria shall be established or approved by the NSAA:

(1) Double Ram Feed Test.

(2) Sympathetic Detonation.

(3) Brush Sensitivity.

(4) 12m Drop. (With bare round and onto the nose)

(5) Impact Shock.

(6) Explosive Decompression.

(7) Acoustic Shock.

d. Shall be subjected to hazard analysis, the results of which are to be acceptable to the NSAA.

e. Shall require the impact energy that causes ignition of the explosive train to be at levels sufficiently high to be acceptable to the NSAA.